WATS 6900: Special Topics: Rivers, sediment & ecology

Fall Semester 2012, 1 credit

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Meeting time and place: Wednesday afternoons, 2 hrs (exact time TBD), BNR 162

Course Objectives:

This course will examine the interactions between sediment and biota in riverine ecosystems. Specifically, we will discuss three topics: 1) the physical science that dictates the spatial distribution and dynamics of stream sediments, 2) the response of stream biota to natural variation in sediment, and 3) the impacts (physical and biotic) of anthropogenic shifts in riverine sediment regimes (sediment starvation, sediment pollution, changes in transport capacity, relative changes in coarse/fine sediment load). With regard to the third topic, we will primarily focus on functional definitions of sediment as a pollutant in river ecosystems, considering both the theoretical basis as well as logistical limitations to managing and regulating sediment at regional to continental scales.

Course Expectations:
This is a graduate level seminar course and your participation is essential to make it a success. The most basic expectation is that you thoroughly read all of the required papers and come prepared to discuss. Each member of the class will be asked to lead the discussion at least once and provide a 1-page executive summary. The executive summary must be circulated to three peer reviewers by noon on the Friday prior to the discussion. Reviewers are expected to provide suggestions in a timely manner such that the discussion leader can revise and send the executive summary to the entire class by noon on the Monday prior to class. Both drafts of the executive summary and all three reviews will be submitted to the instructors by noon on the Monday prior to class.

Readings that require an executive summary are noted in the schedule with an asterisk. The executive summary should include a) some background/context for the study, b) a concise explanation of the study and results, c) a critical assessment

of the study design and analysis, and d) questions for the group to consider prior to the discussion.

Grading:

Executive summary:	30%
Reviews of other's ES:	20%
Preparation for discussions led:	10%
Active weekly participation:	40%

Schedule:

NOTE: * denotes readings for which discussion leader will provide an exec summary

Week	Topic
1	Introduction: Review of physical and ecological perspectives regarding riverine sediment and substrates (RSS): conventional and unconventional wisdom.
2	Understanding the spatial structure and temporal dynamics of RSS – Paper discussion 1 (overview). Burt and Allison, 2010; Naden, 2010
3	Understanding the spatial structure and temporal dynamics of RSS – Paper discussion 2. *Surian, 2002; Topping et al., 2000b
4	Understanding the spatial structure and temporal dynamics of RSS – Paper discussion 3. *Hassan et al., 2005, Hoffman and Gabet, 2007
5	Understanding the spatial structure and temporal dynamics of RSS – Paper discussion 4. *Lane et al., 2008; Nelson et al., 2009
6	Natural variation in RSS as a determinant of the abundance and distribution of stream biota and ecosystem processes – Paper discussion 6 (overview). Minshall 1984, Minshall 1988
7	Natural variation in RSS as a determinant of the abundance and distribution of stream biota and ecosystem processes – Paper discussion 7. *Rabeni et al 2005
8	Natural variation in RSS as a determinant of the abundance and distribution of stream biota and ecosystem processes – Paper discussion 8. *Vaughan et al., 2009
9	Natural variation in RSS as a determinant of the abundance and distribution of stream biota and ecosystem processes – Paper discussion 9. *Montgomery, 2004; Poff and Hart, 2002
10	RSS as a pollutant – Paper discussion 10 (overview). Borah et al. 2007; Wood and Armitage 1997
11	RSS as a pollutant: effects on abundance and distribution of stream biota and ecosystem processes – Paper discussion 11. *Kaufmann et al., 2009

12 RSS as a pollutant: effects on abundance and distribution of stream biota and ecosystem processes – Paper discussion 12. *Shaw and Richardson 2001

13 RSS as a pollutant: effects on abundance and distribution of stream biota and ecosystem processes – *Sutherland et al 2002, Hawkins et al 1983.

14 RSS, ecological responses, and environmental policy: summary discussion.

Required (listed above) and optional reading:

Context, conventional and unconventional wisdom

Allen, J.D., 2004. Landscapes and Riverscapes: The Influence of Land Use on Stream Ecosystems. Annual Reviews of Ecology, Evolution, and Systematics. 35: 25-284.

Benda, L., Poff, N.L., Miller, D., Dunne, T., Reeves, G., Pess, G., Pollock, M. 2004. The Network Dynamics Hypothesis: How Channel Networks Structure Riverine Habitats. BioScience. 54 (5): 413-427.

Measuring Sediment in Streams:

Agrawal, Y.C., Whitmire, A., Mikkelsen, O.A., Pottsmith, H.C., 2008. Light scattering by random shaped particles and consequences on measuring suspended sediments by laser diffraction. J. Geophys. Res., 113(C4), C04023.

Blott, S. and Pye, K., 2001. GRADISTAT: a grain size distribution and statistics package for the analysis of unconsolidated sediments Earth Surface Processes and Landforms. 26 (11), 1237–1248,

Rubin, D.M. 2004. A simple autocorrelation algorithm for determining grain size from digital images of sediment. Journal of Sedimentary Research. 74 (1), 160–165

Rubin, D.M., Chezar, H., Harney, J.N., Topping, D.J., Melis, T.S., Sherwood, C.R., 2007. Underwater microscope for measuring spatial and temporal changes in bed-sediment grain size. Sedimentary Geology. 202: 402-408.

Conceptual introduction to sediment in landscapes and river networks:

Burt, T.P., Allison, R.J., 2010. Sediment Cascades in the Environment: An Integrated Approach, Chapter 1 in *Sediment Cascades*. John Wiley & Sons, Ltd, pp. 1-15.

De Vente, J.; Poesen, J.; Arabkhedri, M.; Verstraeten, G. The sediment delivery problem revisited. Prog. Phys. Geog. 2007, 31, 155–178.

Hooke, J. 2003. Coarse sediment connectivity in river channel systems: a conceptual framework and methodology. Geomorphology. 56: 79–94

Montgomery, D. R. Soil erosion and agricultural sustainability. Proc. Natl. Acad. Sci. 2007, 104, 13268–13272.

Phillips, J. D. Evolutionary geomorphology: thresholds and nonlinearity in landform response to environmental change. Hydrol. Earth Syst. Sci. 2006, 10, 731–742.

Naden, P.S., 2010. The Fine-Sediment Cascade, Chapter 10 in *Sediment Cascades*. John Wiley & Sons, Ltd, pp. 271-305.

Smith, S.M.C., Belmont, P., Wilcock, P.R., 2011. Closing the Gap Between Watershed Modeling, Sediment Budgeting, and Stream Restoration, Stream Restoration in Dynamic Fluvial Systems: Scientific Approaches, Analyses, and Tools. Geophys. Monogr. Ser. AGU, Washington, DC, pp. 293-317.

Trimble, S.W., Crosson, P., 2000. U.S. Soil Erosion Rates: Myth and Reality. Science, 289(No. 5477), 248-250.

Walling, D.E., 1983. The sediment delivery problem. Journal of Hydrology, 65(1-3), 209-237.

Grain size dynamics:

Nelson, P.A., J.G. Venditti, W.E. Dietrich, J.W. Kirchner, H. Ikeda, F. Iseya, and L.S. Sklar. 2009. Response of bed surface patchiness to reductions in sediment supply. Journal of Geophysical Research. 114, F02005, doi:10.1029/2008JF001144

Surian, N., 2002. Downstream variation in grain size along an Alpine river: analysis of controls and processes. Geomorphology. 43: 137-149.

Topping, D.J., D.M. Rubin, L.E. Vierra, Jr., 2000. Colorado River sediment transport 1. Natural sediment supply limitation and the influence of Glen Canyon Dam. Water Resources Research. 36 (2): 515-542.

Topping, D.J., D.M. Rubin, J.M. Nelson, P.J. Kinzel III, I.C. Corson. 2000b. Colorado River sediment transport 2. Systematic bed-elevation and grain-size effects of sand supply limitation. Water Resources Research. 36 (2): 543-570.

Walling, D.E., Moorehead, P.W., 1989. The particle size characteristics of fluvial suspended sediment: an overview. Hydrobiologia, 176-177(1), 125-149.

Sediment supply and channel morphology

Finnegan, N. J., L. S. Sklar, and T. K. Fuller (2007), Interplay of sediment supply, river incision, and channel morphology revealed by the transient evolution of an experimental bedrock channel, *J. Geophys. Res.*, 112, F03S11, doi:10.1029/2006JF000569.

Hassan, M.A., Church, M. Lisle, T.E., Brardinoni, F., Benda, L., and Grant, G.E., 2005. Sediment Transport and Channel Morphology of Small, Forested Streams. Journal of the American Water Resources Association (JAWRA) 41(4):853-876.

Hoffman, D.F., E.J. Gabet. 2007. Effects of sediment pulses on channel morphology in a gravel bed river. Geological Society of America Bulletin. 119 (1/2): 116–125; doi: 10.1130/B25982.1

Lane, S.N., S.C. Reid, V. Tayefi, D. Yu, R.J. Hardy 2008. Reconceptualising coarse sediment delivery problems in rivers as catchment-scale and diffuse. Geomorphology. 98: 227–249

Sediment-biota interactions:

Harrison, E.T., R.H. Norris, S.N. Wilkinson, 2007. The impact of fine sediment accumulation on benthic macroinvertebrates: implications for river management. In Proceedings of the 5th Australian Stream Management Conference. Australian rivers: making a difference. Eds Wilson, A.L., Dehaan, R.L., Watts, R.J., Page, K.J., Bowmer, K.H., & Curtis, A. Charles Sturt University, Thurgoona, New South Wales.

Hawkins, C. P., M. L. Murphy, N. H. Anderson, and M. A. Wilzbach. 1983. Density of fish and salamanders in relation to riparian canopy and physical habitat in streams of the northwestern United States. Can. J. Fish. Aquat. Sci. 40: 1173-1185.

Henley, W.F., M.A. Patterson, R.J. Neves, A.D. Lemly. 2000. Effects of sedimentation and turbidity on lotic food webs: A concise review for natural resource managers. Reviews in Fisheries Science. 8 (2): 125-139.

Minshall, G.W., 1984. Aquatic insect-substratum relationships. In The ecology of aquatic insects. Edited by V.H. Resh and D.M. Rosenberg. Praeger Scientific, New York, NY.

Minshall, G.W., 1988. Stream ecosystem theory: a global perspective. J. North. Am. Benthol. Soc. 7: 263-288.

Montgomery, D. R., 2004. Geology, geomorphology, and the restoration ecology of salmon, GSA Today. 14 (11): 4-12.

Palmer, M. A.; et al. Linkages between aquatic sediment biota and life above sediments as potential drivers of biodiversity and ecological processes. BioScience 2000, 50, 1062–1075.

Poff, N.L., Hart, D.D. (2002) How Dams Vary and Why It Matters for the Emerging Science of Dam Removal. Bioscience. 52(8): 659-668.

Rabeni C.F., Doisy K.E. & Zweig L.D. (2005) Stream invertebrate community functional responses to deposited sediment. Aquatic Sciences, 67, 395–402.

Shaw, E.A. and Richardson, J.S., 2001. Direct and indirect effects of sediment pulse duration on stream invertebrate assemblages and rainbow trout

(Oncorhynchus mykiss) growth and survival. Can. J. Fish. Aquat. Sci. 58: 2213-2221.

Sutherland, A.B., J.L. Meyer, E.P. Gardiner. 2002. Effects of land cover on sediment regime and fish assemblage structure in four southern Appalachian streams. Freshwater Biology. 47: 1791–1805

Wood, P. J., & Armitage, P. D. (1997). Biological effects of fine sediment in the lotic environment. Environmental Management, 21: 203-217.

Sediment as a pollutant

Aksoy H., M.L. Kavvas. 2005. A review of hillslope and watershed scale erosion and sediment transport models. Catena. 64: 247-271.

Kaufmann, P.R., J.M. Faustini, D.P. Larsen, M.A. Shirazi. 2008. A roughness-corrected index of relative bed stability for regional stream surveys. Geomorphology. 99: 150–170

Kaufmann, P.R, P. Levine, E.G. Robison, C. Seeliger, and D.V. Peck. 1999. Quantifying Physical Habitat in Wadeable Streams. EPA/620/R-99/003. U.S. Environmental Protection Agency, Washington, D.C.

Kaufmann, Philip R., David P. Larsen, and John M. Faustini, 2009. Bed Stability and Sedimentation Associated With Human Disturbances in Pacific Northwest Streams. Journal of the American Water Resources Association. 45(2): 434-459. DOI: 10.1111/j.1752-1688.2009.00301.x

Slob A., Gerrits L. 2007. The Dynamics of Sedimentary Systems and the Whimsicality of Policy Processes. J Soils Sediments 7 (5) 277–284.

Owens, P. 2009. Adaptive management frameworks for natural resource management at the landscape scale: implications and applications for sediment resources. Journal of Soils and Sediments. 9: 578-593.

Borah , D.K., G. Yagow, A. Saleh, P.L. Barnes, W. Rosenthal, E.C. Krug, L.M. Hauck. 2007. Sediment and nutrient modeling for TMDL development and implementation. Transactions of the ASABE. 49 (4): 967-986.